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(71) Applicant: PICKER INTERNATIONAL, INC.
595 Miner Road
Highland Heights Ohio 44143(US)

(72) Inventor: Hunt, Robert P.
365 Forest Avenue
Palo Alto California 94301(US)
Inventor: Gilbrom, David L.
1274 Thurston Avenue
Los Altos California 94022(US)

(74) Representative: Pope, Michael Bertram Wingate
Central Patent Department Wembley Office
The General Electric Company, p.l.c. Hirst Research Centre East Lane
Wembley Middlesex HA9 7PP(GB)

(54) **Monitoring systems and methods.**

(57) In a monitoring system, a tachometer (32) monitors the speed of a continuously moving web or article (12). A lens (20) focuses an image of a portion of the web in an examination region (14) on image section (22) of a CCD array. As the web moves, the image moves correspondingly along the image section. A synchronizing circuit (C) adjusts the frequency of a tachometer output signal and uses it in lieu of a fixed frequency oscillator as the master clocking or timing basis for generating clocking pulses for the CCD array. More specifically, the synchronizing circuit generates four phase clocking pulses which shifts lines of CCD data along the image section at the same speed that the image is moving along the CCD section. In this manner, the pixel values integrate light from the same area of the imaged web at each shifted position along the image section. Each line of data from the image section may be shifted at the same rate through an optically light-insensitive storage section and read out serially by shift rgisters to form a video signal. A quality control analysis circuit (D) monitors the video signal for selected characteristics of the imaged web. Preferably, a record is maintained of the location of flaws and defects noted by the quality analysis circuit.

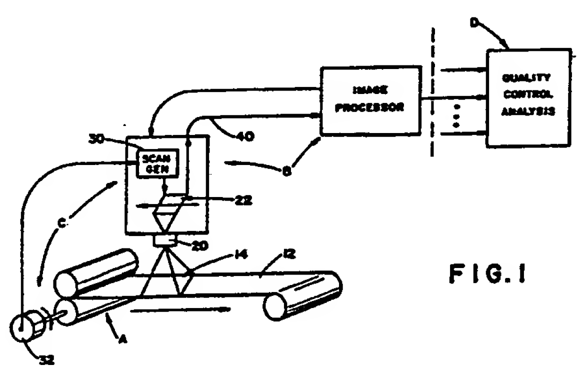

FIG.1

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Monitoring Systems and Methods

This invention relates to monitoring systems and methods.

It finds particular application in conjunction with quality control and monitoring of continuous material processes, and will be described with particular reference thereto. It is to be appreciated, however, that the invention may find other applications including stop action photography, low light photography, photographic archivial recording, intermittent condition monitoring, video security, and the like.

Heretofore, quality control and monitoring has been carried out with charge coupled devices (CCD) and other video cameras. In one method, a video output signal was generated which included a long, continuous series of video image fields. In a transfer CCD camera, light was focused on an image section of a CCD sensor for a selected interval of time. The interval was selected to produce good image contrast with the amount of light received, e.g. 1/60th of a second. The charge on each element of the image section was indicative of received light intensity. The charge was transferred during a vertical blanking interval, e.g. a few hundred microseconds, into corresponding elements of an optically insensitive CCD mass storage section. As the image section again commenced integrating received light, the charge was read out element by element from the optically insensitive elements to form a video signal representing one field of the resultant image. After the 1/60th of a second or other selected light reception interval, the charge representing the second field was transferred from the image section to the storage section. As the second field was read out of the storage section, the second video signal image section started integrating light to form a third field. This sequence was repeated cyclically to form a video signal representing a series of single image fields.

Continuous production of image fields rendered CCD cameras awkward to adapt for certain high volume quality control situations. As a continuous sheet or individual object was moved past the CCD camera, the resultant video signal represented a long series of image fields. In order to review the images of each object to monitor for a controlled characteristic, it was first necessary to determine which portion of the video signal included the field(s) which represented the monitored individual object or portion of the continuous sheet. Second, it was necessary to determine within the field the actual location of the monitored object or sheet portion. When increased lighting was necessary, the actuation of a strobe light was coordinated with the field of interest. If the strobe light was not completely coincident with a common location of the object or sheet portion within the field(s) of interest, lighting intensities and object shapes would vary among the fields of interest for each object or sheet portion. If the stream of objects or sheet was moving rapidly compared with 1/60th of a second or other one field exposure time, then each object would be in a different position within the selected field of interest. This different positioning of the object not only required identifying the object position in the video field, but could also result in different lighting conditions on the object. These inaccuracies in the timing, positioning, and lighting of the monitored objects all limited the degree of accuracy and the speed with which quality control monitoring could be performed.

In a proposed quality control and monitoring method, a CCD device is asynchronously triggered at a controlled instant in time to "grab" a moving object. The instant in time is synchronized with the moving object's entry to a preselected examination point. A high intensity strobe is flashed concurrently with asynchronously triggering a CCD device to "grab" the moving object. While such a method has certain unique advantages, it requires a significant amount of power capacity to flash the high intensity light necessary for its functioning. The minimum cycle time of the strobe limited the speed of the conveying system.

Although asynchronous triggering is applicable to continuous web monitoring, some webs are advanced at such high speeds that the repower time of the strobe may limit the web advancement speed. Processes in which continuous webs are advanced include the fabrication of sheets and films of plywood, paper and wood pulp products, fabrics, plastics, MYLAR, CELANAR, KAPTON, vinyls, foamed synthetic material, etc.

It is an object of the present invention to provide a monitoring system and method wherein the above problems are overcome.

According to a first aspect of the present invention there is provided a monitoring system comprising: a conveying means for transporting an object to be examined through an examination region; an optical system for focusing light from the examination region onto an image section comprising an array of light sensitive elements which are each sensitive to light received through the optical system to produce individual pixel values that are indicative of an amount of light received; a transfer means for serially shifting the pixel values across the light sensitive elements to create a video signal representing an image of the examination region;

and a control means for controlling the transfer means, characterised in that the pixel values are shifted in synchronization with movement of the conveying means.

According to a second aspect of the present invention there is provided a monitoring system comprising: a charge coupled device array including: an image section comprising an array of light sensitive elements for accumulating pixel values indicative of a cumulative amount of light received; a storage section having an array of pixel storage elements, the storage section being electrically connected with the image section such that the pixel values can be transferred from the image section to the storage section; and a serializing means for serializing the pixel values from the storage section into a video signal; a conveying means for conveying a continuous web; means for continuously focusing light on the image section; a clock means for generating clock signals for transferring pixel values from the image section to the storage section, from the storage section to the serializing means and from the serializing means to produce said video signal; a monitoring means for monitoring the video signal for at least one preselected characteristic; and a recording means for recording any locations along the web corresponding to the monitored characteristic, characterised by synchronizing means operatively connected to the clock means for synchronizing the transfer of the pixel values at least in the image section with movement of the conveying means.

According to a third aspect of the present invention there is provided a method of monitoring comprising the steps of: (a) moving an object to be examined through an examination region; (b) illuminating the object with light from a light source, as the object moves through the examination region; (c) projecting an image of the moving object onto an image sensor, the image moving across the image sensor with movement of the object; (d) shifting integrated light values formed in the image sensor along the image sensor from the image sensor to an output register; (e) syncronizing the movement of the object through the examination region and the shifting of the integrated light values; (f) reading integrated light values from the output register in the form of a serial stream of pixels to produce a video signal representing a video image; and (g) monitoring at least one characteristic of the object from the video signal.

One monitoring system and method in accordance with the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a diagrammatic illustration of the system; and

Figures 2A, 2B and 2C together constitute a more detailed diagrammatic illustration of the system of Figure 1.

Referring to Figure 1, the system comprises a conveying means A which moves a continuous web or other object(s) to be examined through an examination region at an adjustable speed. A CCD camera or opto-electrical transducer system B monitors the moving object by focusing an image of the moving object on an opto-electric transducer. As the object moves, the image moves correspondingly along the transducer. A sycnchronizing control means C synchronizes and coordinates movement of the object and conversion of the image into an electronic video signal by the camera. Specifically, the transducer samples the same element or pixel of an image several times. The synchronizing means causes the multiple samplings corresponding to the same pixel of the image but sampled at different regions of the transducer to be integrated. The synchronising means preferably adapts the sampling of the transducer to movement of the object. However, in some applications it is advantageous to vary the speed of the object to match the sampling of the transducer. A quality control analysis means D analyses the video signal for flows, defects, or other characteristics of the web and denotes their locations.

With continuing reference to Figure 1 and further reference to Figures 2A, 2B and 2C, the conveying means A includes a conventional conveyor 10 for moving object 12 through the examination region 14. The nature of the conveyor is dependent on the object to be transported, as is known in the art. In the preferred embodiments, the conveyor includes rollers for a continuous web of floor coverings, wall paper, or other finished sheet goods. The continuous web may include polymeric films such as MYLAR, CELANAR, KAPTON, vinyls, plywood, paper products, etc. Alternatively, the conveyor may include a belt for carrying the articles. Optionally, the conveyor may have pockets, recesses, or clamps for fixing the position of each received object on the belt.

The examination region 14 is continuously illuminated by light from a lighting means 16.

The camera **B** includes an optical system, such as a lens **20**, which focuses light received from the examination region on a light sensitive area **22**, preferably a bidirectional array of CCD elements. The lens focuses light emanating from the examination region continuously onto the light sensitive area or image section of the optoelectrical transducer. The resolution of the resultant image is determined by the number of CCD elements in each dimension. The more elements, the finer the resolution. A typical video camera might have a 244 x 610 element array. For color, three times as many elements are provided. A third of the ele-

ments have a green filter, a third have a blue filter, and a third have a red filter, or any other three color filter combination as is conventional in the art.

In conventional CCD cameras, the data is periodically shifted from the image section **22** to a light shielded storage section **24** during a vertical flyback period which erases or resets each element of the CCD image section. In the present embodiment, the vertical flyback signals are defeated and the image section and storage section transfer lines are both connected to the synchronizing means C to cause lines of pixels to be stepped continuously at a line frequency rate to output registers **26**. When the web has a "star" which passes through the examination region for a very short time interval relative to the line transfer rate, then with each succeeding line interval, the image is progressively transferred or shifted along the light sensitive area into the storage section **24**.

That is, the object being imaged and its image on the CCD array move in precise synchronization with the shifting of charge values along the CCD array. For example, if the lens **20** focuses a 1 millimeter x 1 millimeter area of the object on each element of the CCD array, then each time the object moves 1 millimeter, the pixel or integrated light values are shifted one line in the CCD array. In this manner, subsequent images on the CCD array superimpose directly on shifted previous images. By the time an image value or line of image values reaches the optically insensitive storage section **24** of the sensor, the optic information from the object has been integrated over the entire transfer period (1/60 seconds, for example). With the 244 x 610 CCD array, each pixel value represents the sum of light received at each of 244 CCD elements. The synchronization means C keeps monitored object movement and the image sensor transfer process in precise synchronization. In the preferred embodiment, the speed of the conveyor rollers, drive motors, or the like is converted by the synchronization means into clocking signals for the CCD array. Alternatively, signals from clocking electronics in the camera may readjust and control the speed of the drive motors of the conveyor.

With combined reference to FIGURES 2A,2B and 2C,clocking electronics **30** receives a trigger signal t_t from a conveyor speed sensor or tachometer **32** and produces clock pulses **ϕ1A** - **ϕ4A** and **ϕ1B** - **ϕ4B** to clock the CCD array at a corresponding rate. More specifically, the trigger signals control the frequency of an image section transfer clock or means **34**, which supplies the clock signals to a light image sensor section control means **22a** and a storage section control means **24a**. The light image sensor control means **22a** causes the charge of each image element or row of elements of the image section **22** to be shifted. More specifically, the four phase image section transfer clock signal **ϕ1A** - **ϕ4A** shifts the charge line by line. After just about 244 pulses or shift commands in the illustrated 244 active line image section embodiment, a line of charge values has been shifted 244 lines from the first line of the image section into the storage section **24**.

The clocking signals are selected such that the image transfer is synchronized with the movement of the conveyor. The controller **C** conveys identical transfer clock pulses **ϕ1B** - **ϕ4B** to the storage section control means **24a** as sent to the image section control means **22a** to cause the data from the storage section **24** to be shifted line by line into the shift registers means **26**. To enable the camera to operate in either a conventional field mode or the time delayed integration mode, the storage section is the same size as the image section. If the camera is limited to the time delayed integration mode, the storage section may be much smaller or even eliminated.

For a color video image rendition, a red shift register **26r**, a blue shift register **26b**, and a green shift register **26g** are provided. Once a line of pixel or integrated light values have been transferred from the storage section **24** to the shift registers, a shift register clocking means **36** sends higher speed three phase shift register clock signals **ϕ1C** - **ϕ3C** to a shift register controller **26a**. The shift registers serially step each charge or data value onto video signal output lines **40** before the next line is loaded into the shift registers from the storage section. Thus, between image or storage section transfer clock pulses, a number of shift register clock pulses equal to the number of elements per line are generated to clock out red, green, and blue output signals.

Feedback amplifiers **42** combine each of the three color output signals with a feedback signal which establishes a DC reference level to minimize the interfering effects of clock noise. A gain adjusting amplifier means **44** adjusts the gain of all three signal components correspondingly. A black and white/color mode selecting means **46** selects whether a black and white or color composite video signal is to be produced.

If a black and white image is selected, a summing means **50** sums the three color components corresponding to each pixel and feeds the data to a first video signal processing channel **52**. The video channel includes an impedance adjusting amplifier **54** for providing a low impedance output signal. A band pass filter **56** removes any vestiges of clocking signal noise or the like. A user controlled gain amplifier **58** amplifies the signal from the band pass filter and passes it to a clamping means **60** which restores the DC video. At the end of each horizontal sweep line, the clamping means shorts

to a DC reference level to restore a DC level that sets the black level of the resultant image. A synchronization information means **62** switches between lines to reference voltages to add blanking and horizontal synchronization information to the signal. A feedback circuit **64** feeds back a portion of the composite video signal to provide a phase sensitive detection of the clocking to establish the DC level that minimizes the clock noise.

If a color output is selected, then the switching means **46** connects two components of the output signal to analogous video processing channels **52′**, **52″**. By convention, the synchronization means **62** only adds synchronization information to one, generally the green, video component. Preferably, the feedback signal also is based on a single one of the components. The video processing circuitry is stable to better than one part in 256 to enable precision digitizing and digital signal processing of the resultant video signal.

The quality control analysis means **D** receives the composite video signal and operates on it in a manner that is appropriate to the quality control function undertaken. For example, the analysis means **D** may turn the composite signal into a man-readable video image. Alternately, the analysis means may examine components of the video signal corresponding to selected regions to determine whether they meet preselected characteristics relative to each other, preselected standards, or the like.

Looking by way of example to monitoring a continuous web of solid color material, the image of the web may change in gray scale or color relative to the rest of the web image. The change may be the result of color changes in the web or surface deformates that alter the amount of reflected light. The pixel values of the video signal of the web are compared with a preselected gray scale characteristic or value to determine if the web is deformed or damaged beyond selected tolerances. If the web has a repeating pattern, the image or video signal is compared with corresponding standards which change cyclically with the pattern to determine whether the web has been accurately processed. If the web is monitored in color, each image or pixel value of the video signal is compared with one of a plurality of colorimetric standards in accordance with a location within the pattern. Alternately, color or other physical parameters may be used to sort various types or grades of products. Numerous other sorting, quality control, and acceptance algorithms may be implemented as are appropriate to the requirements of the objects being examined.

The synchronizing means **C** further includes a 22.657 MHz internal crystal oscillator **70** for defining the image section transfer clock pulses in a normal interleaved frame video mode. In the time delayed integration mode of the present invention, the trigger signals t_t from the tachometer **32** replace the crystal oscillator as the timing basis. The tachometer in the illustrated embodiment includes a light which shines through apertures of a disc attached to a guide roller that rotates with the conveying means and impinges on a photocell. The photocell sends a trigger pulse t_t each time an incremental length of the scontinuous web product has passed through the examination region. In this manner, the trigger signal t_t has a frequency that is proportional to the web speed. The frequency of the trigger signal is adjusted by the synchronization means to provide the timing of the transfer clock signals **ϕ1A - ϕ4A**, **ϕ1B - ϕ4B**, and **ϕ1C - ϕ3C** sent to the image section control means **22a**, and storage section control means **24a**, and the read out control means **26a**.

A high frequency detector **72** disables crystal oscillator **70** to synchronize the CCD camera with an external master clock signal, e.g. the trigger signal or other signal indicative of web movement. The trigger signal is frequency adjusted by dividers **74**, **76** to adjust a sync or master clock frequency generator **78**. Initialization pulses are received by a horizontal drive input **80** and vertical drive input **82**. The sync generator **78** synchronizes the horizontal and vertical drive pulses with the master clock signal.

A multi norm pulse pattern generator (MNPPG) **84** is controlled by the sync generator and the vertical and horizontal drive signals to provide clock signals for the image section, storage section, and shift register of a conventional CCD video camera operation in a field or frame mode. Commonly, a first four phase clock signal is provided for the image section; a second four phase clock signal is provided for the storage section; and a three phase clock signal is provided for the shift registers. The multi-norm pulse pattern generator also provides transfer gate pulses TG1, optical blanking and clamping pulses, and start and stop pulses to reset the three phase clock.

However, as indicated above, in the time delayed integration mode, the pixel values in only the first line of the CCD array are refreshed each time. These pixel values are shifted along both the image and storage sections at a selectable speed and received light at each position is integrated. This is as opposed to the rapid transfer of pixel values from the image region to the storage region once per field in conventional operation.

A processor **90** replaces the multi norm pulse pattern generator in the time delayed integration mode of the preferred embodiment. A frequency adjusting means **92**, e.g. a frequency doubler, adjusts the master clock frequency as is appropriate to the number of lines of elements in the CCD

array, the size of the examination region, and the magnification reduction of the camera optic system. A counter **94** counts the clock pulses whose frequency is determined by the tachometer **32**. With the illustrated 244 line CCD image section, a six bit counter is utilized such that each increment of the count (up to 244) causes the clock signal to shift the pixel values one line. A TDI wave generator **96** and a logic circuit **98** are addressed by the six bit signal to create and step the four phase clock signal in accordance with counted six bit value. The timing of the clock signal is such that the pixel values shift or step along the image and storage sections synchronously with the movement of the web. More specifically, the generator and logic circuit create a pair of four phase clock signals analogous to the MNPPG clock signals for shifting lines of data from the storage section into the shift register but without the pause for vertical blanking. In the preferred embodiment, the shifting is also at a slower speed than conventional. The three phase clock signal for the shift register is essentially the same as created by the MNPPG. After the count reaches the number of lines in the image section, the logic circuit **98** rests the counter **94**. A multiplexor **100** conveys the continuous four phase clock signals to vertical drivers **102** and **104** for the image and storage sections respectively. The outputs of the vertical drivers **102**, **104** are continuous four phase clock signals whose frequency and relative 1 phasing are determined by the tachometer **32**.

The preferred embodiment can be operated either in the above described time delay integration mode or as a conventional video camera. When the time delayed integration mode is selected, an approximate input on the vertical driver input **82** causes a mode select means **106** to cause the multiplexor to send the above described TDI clock sequences to the vertical drivers **102**, **104**. An appropriate input on the horizontal drive input **80** initializes the six bit counter. When the conventional frame mode is selected, conventional horizontal and vertical drive signals are applied at inputs **80**, **82** which enables the mode select means to cause the multiplexor to pass the conventional clocking output of the MNPPG **84**.

The outside master clock signal is also reduced by a three phase clock divider **110**. A clock mix means 112 coordinates the three phase clock signals from the three phase clock divider **110** with the four phase image transfer clock signal. A voltage shift means **114** matches the three phase clock signal voltage with the video output shift register control **26a**.

Claims

1. A monitoring system comprising: a conveying means (A) for transporting an object (12) to be examined through an examination region (14); an optical system (20) for focusing light from the examination region (14) onto an image section (22) comprising an array of light sensitive elements which are each sensitive to light received through the optical system (20) to produce individual pixel values that are indicative of an amount of light received; a transfer means (22a,b) for serially shifting the pixel values across the light sensitive elements to create a video signal representing an image of the examination region (14); and a control means (C) for controlling the transfer means (22a, b), characterised in that the pixel values are shifted in synchronization with movement of the conveying means (A).

2. A system according to Claim 1 further including a storage section (24) connected with the image section (22) for receiving pixel values therefrom and wherein the control means (C) causes the transfer means (22a,b) to transfer pixel values from the image section (22) to the storage section (24) in synchronization with movement of the conveying means (A) and to transfer the pixel values serially from the storage section (24) to create the video signal.

3. A system according to Claim 2 further including common clocking means (78) for said image (22) and storage (24) sections such that pixel values in the image (22) and storage (24) sections are shifted at a common rate.

4. A system according to any one of Claims 1 to 3 wherein the control means (C) includes a clock generator (78) for generating clock pulses for controlling shifting of pixel values across the image section (22).

5. A system according to Claim 4 wherein the control means (C) further includes a monitoring means (32) for monitoring the speed of the converying means (A), the clock generator (78) being connected with the monitoring means (32) such that the frequency of clock pulses generated by the clock generator (78) is controlled in accordance with the monitored conveyor speed.

6. A monitoring system comprising: a charge coupled device sensor array (22, 24, 26) including: an image section (22) comprising an array of light sensitive elements for accumulating pixel values indicative of a cumulative amount of light received; a storage section (24) having an array of pixel storage elements, the storage section (24) being electrically connected with the image section (22) such that the pixel values can be transferred from the image section (22) to the storage section (24); and a serializing means (26) for serializing the pixel values from the storage section (24) into a video

signal; a conveying means (A) for conveying a continuous web (12); means (20) for continuously focusing light on the image section (22); a clock means (78) for generating clock signals for transferring pixel values from the image section (22) to the storage section (24), from the storage section (24) to the serializing means (26) and from the serializing means (26) to produce said video signal; a monitoring means (D) for monitoring the video signal for at least one preselected characteristic; and a recording means (D) for recording any locations along the web (12) corresponding to the monitored characteristic, characterised by synchronizing means (C) operatively connected to the clock means (78) for synchronizing the transfer of the pixel values at least in the image section (22) with movement of the conveying means (A).

7. A method of monitoring comprising the steps of: (a) moving an object (12) to be examined through an examination region (14); (b) illuminating the object (12) with light from a light source, as the object (12) moves through the examination region (14); (c) projecting an image of the moving object (12) onto an image sensor (22, 24), the image moving across the image sensor (22, 24) with movement of the object (12); (d) shifting integrated light values formed in the image sensor (22, 24) along the image sensor (22, 24) from the image sensor (22, 24) to an output register (26); (e) syncronizing the movement of the object (12) through the examination region (14) and the shifting of the integrated light values; (f) reading integrated light values from the output register (26) in the form of a serial stream of pixels to produce a video signal representing a video image; and (g) monitoring at least one characteristic of the object (12) from the video signal.

8. A method according to Claim 7 wherein the image sensor (22, 24) comprises a charge coupled device array (22, 24) comprising a light sensing array (22) and a storage array (24) and wherein the step of reading integrated light values includes: (a) transferring integrated light values from the light sensing array (22) to the storage array (24); and (b) serially transferring the integrated light values from the storage array (24) to the output register (26).

9. A method according to Claim 7 wherein the image sensor (22, 24) comprises a charge coupled device array (22, 24) comprising a light sensing array (22) and a storage array (24), the object (12) is a continuous web (12) and the step of shifting integrated light values includes shifting the integrated light values along the charge coupled device array (22, 24) in proportion to movement of the continuous web (12) such that subsequent sensing of the continuous web (12) superimposes integrated light values corresponding to a common area of the continuous web (12).

10. A method according to Claim 9 further including repeating the step of shifting integrated light values a plurality of times until that area of the object (12) being sensed is transferred into the storage array (24).

11. A method according to Claim 10 further including shifting the integrated light values along the light sensing array (22), transferring the integrated light values from the light sensing array (22) to the storage array (24) and shifting the integrated light values along the storage array (24) to the output register (26) at the same clocking speed.

12. A method according to any one of Claims 7 to 11 wherein the illuminating step includes illuminating the object continuously.

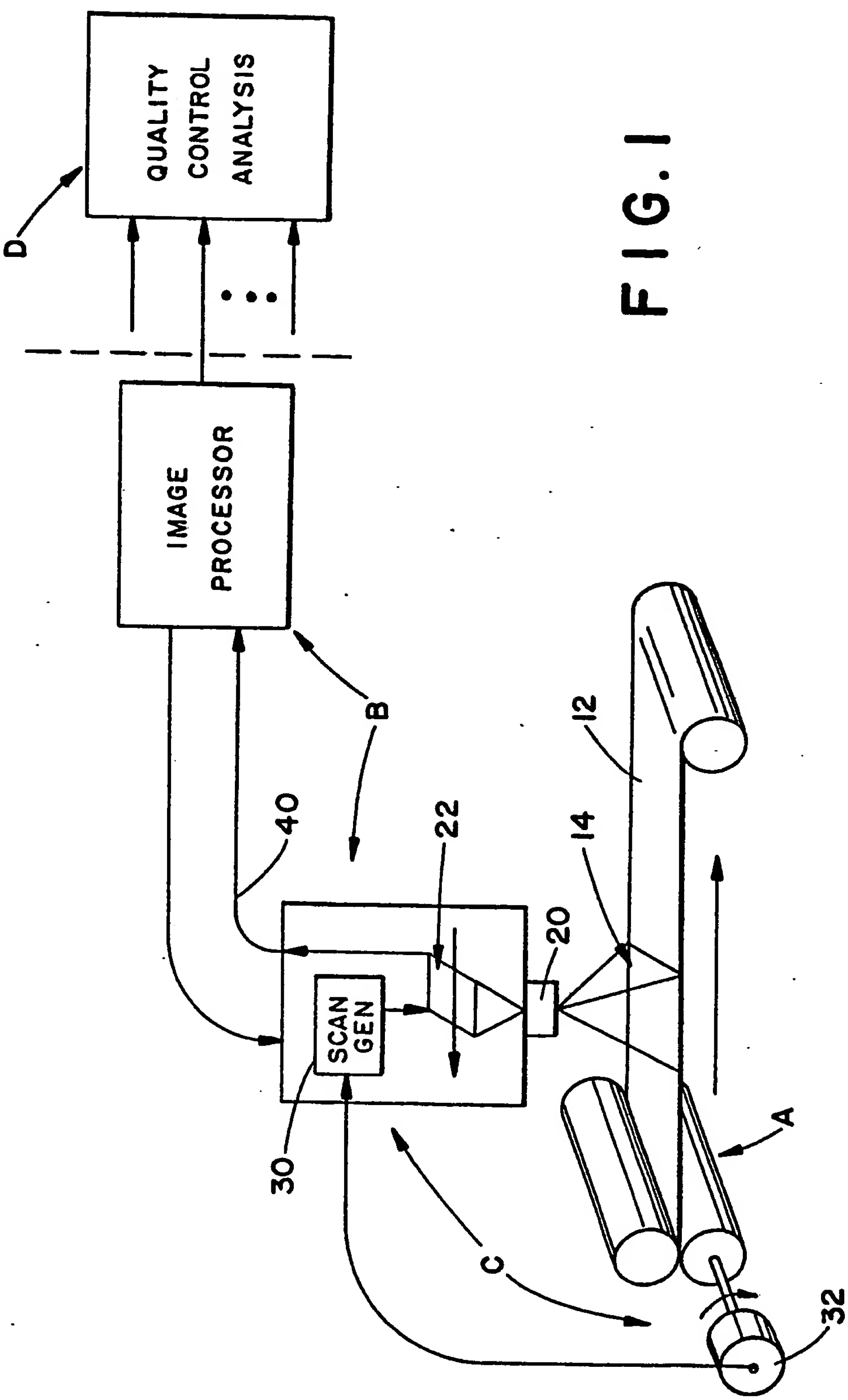
D
QUALITY CONTROL ANALYSIS
IMAGE PROCESSOR
B
40
22
20
14
12
SCAN GEN
30
A
C
32

FIG. I

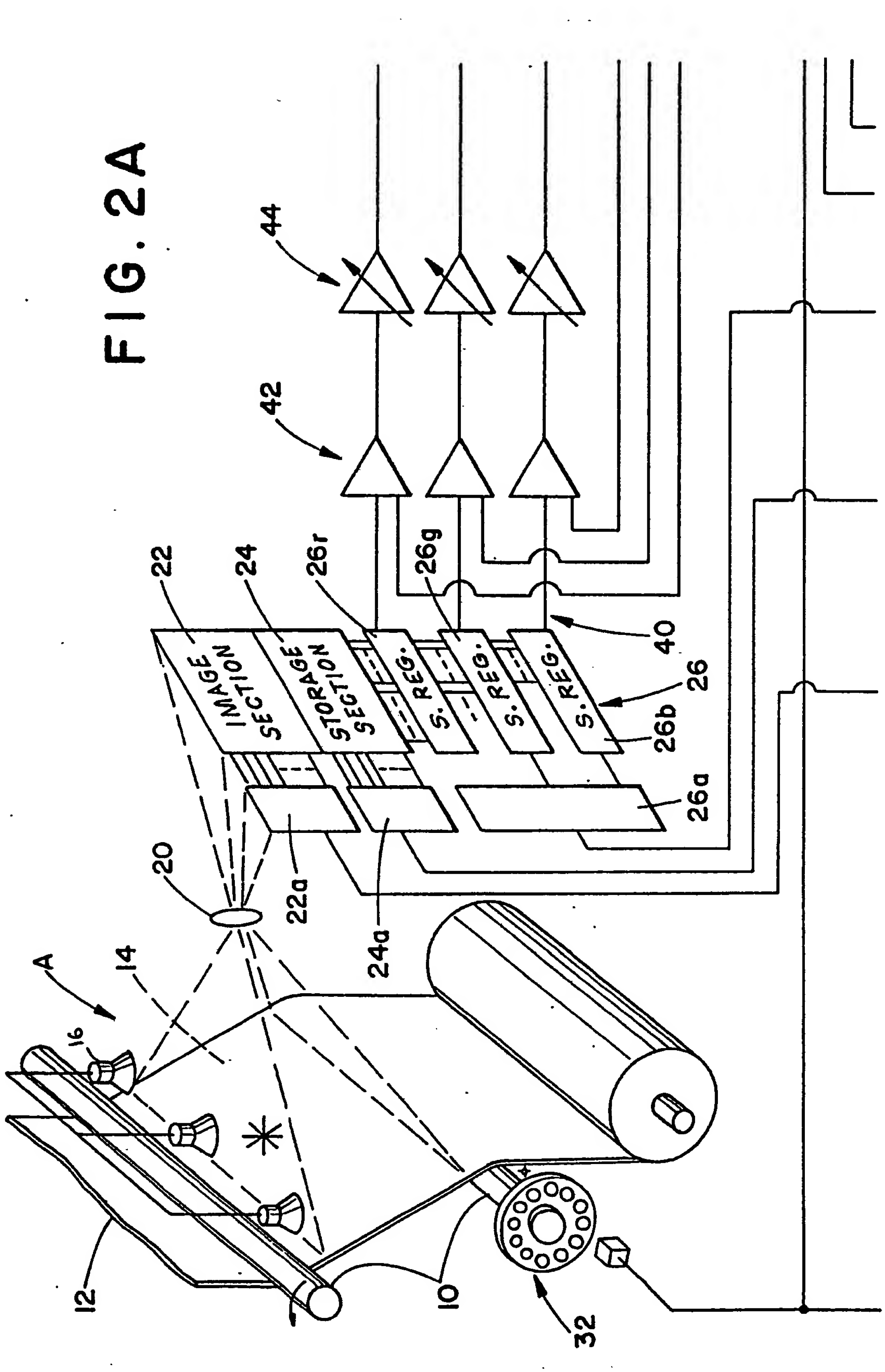
IMAGE SECTION
STORAGE SECTION
S. REG.
S. REG.
S. REG.
22
24
26r
26g
40
26
26b
26a
22a
24a
20
A
14
16
12
10
32
42
44

FIG. 2A

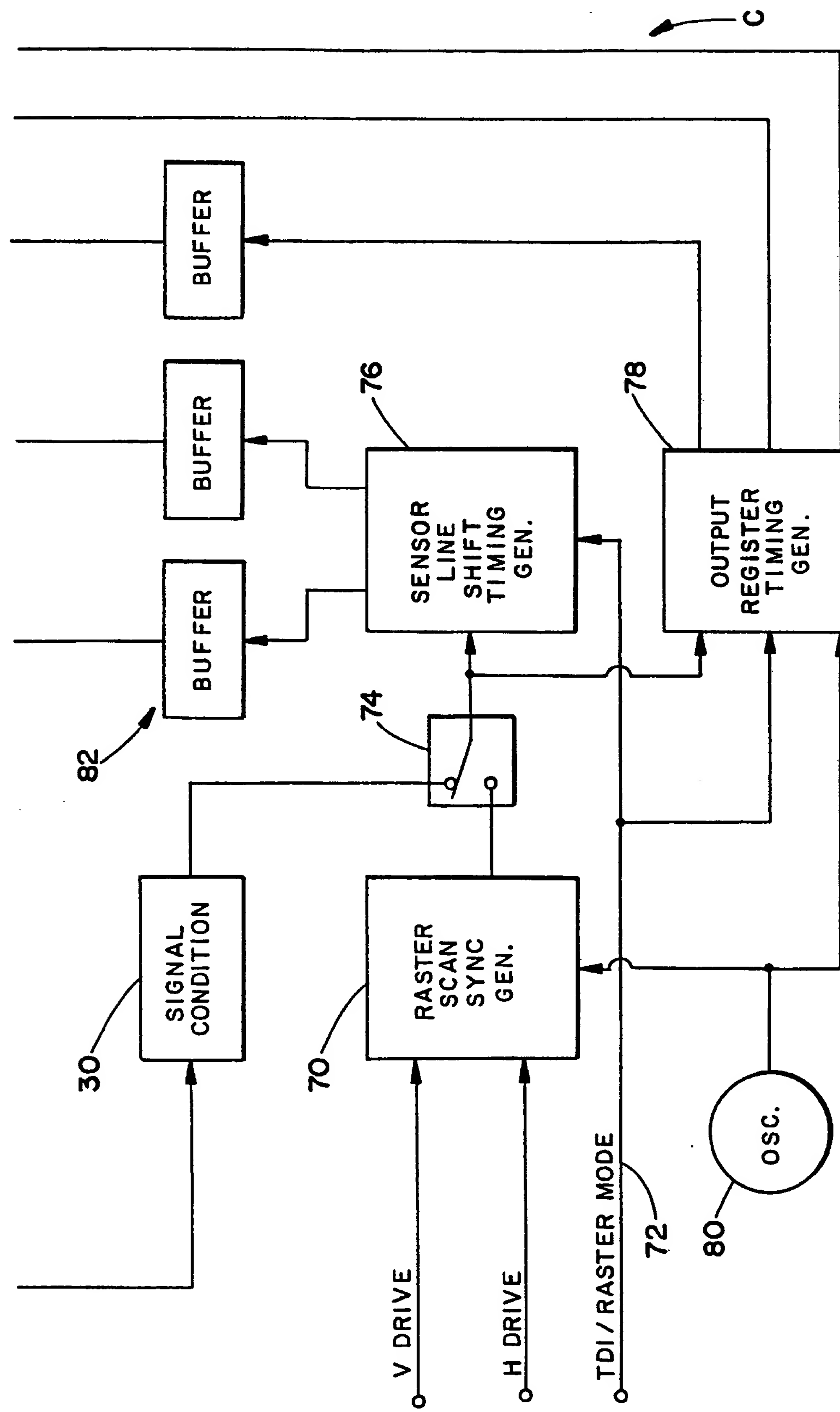
C
BUFFER
BUFFER
BUFFER
82
76
SENSOR LINE SHIFT TIMING GEN.
78
OUTPUT REGISTER TIMING GEN.
74
30
SIGNAL CONDITION
70
RASTER SCAN SYNC GEN.
V DRIVE
H DRIVE
TDI / RASTER MODE
72
OSC.
80

FIG. 2B

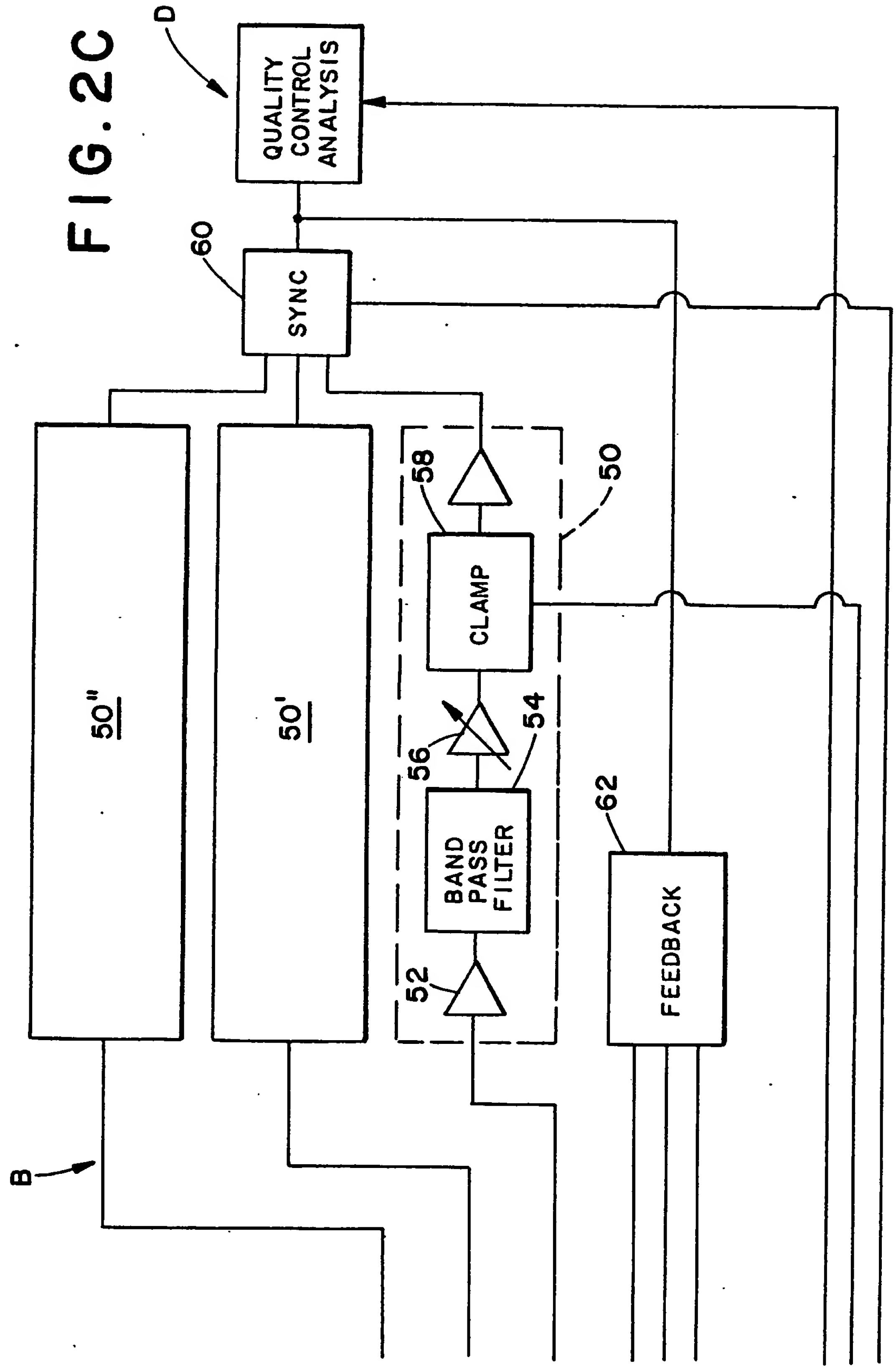
D
QUALITY
CONTROL
ANALYSIS
60
SYNC
50"
50'
58
50
CLAMP
56
54
BAND
PASS
FILTER
52
62
FEEDBACK
B

FIG. 2C

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 30 8534

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	US-A-4 578 810 (J. W. MAC FARLANE et al.) * figure 1; column 5, lines 3-39 * ---	1-4,6,7	G 01 N 21/89 G 06 F 15/70
Y	EP-A-0 194 331 (TOPPAN PRINTING et al.) * figure 7; page 14, lines 19-30 * ---	1-4,6,7	
A	EP-A-0 234 492 (H. K. PINSCH GMBH & CO.) * figures 1,2; claim 1 * ---	1	
P,A	EP-A-0 311 991 (FUTEC INC.) * figure 1; claim 1 * ---	1	
A	US-A-4 641 256 (J. E. MARCHEGIANO et al.) * figures 1,2; abstract * ---		
A	US-A-4 223 346 (G. L. NEIHEISEL et al.) * figure 7; abstract * ---		TECHNICAL FIELDS SEARCHED (Int. Cl.5)
A	US-A-3 835 332 (R. E. BRIDGES) * figure 1; abstract * -----		G 01 N G 06 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	22-12-1989	BREUSING J

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